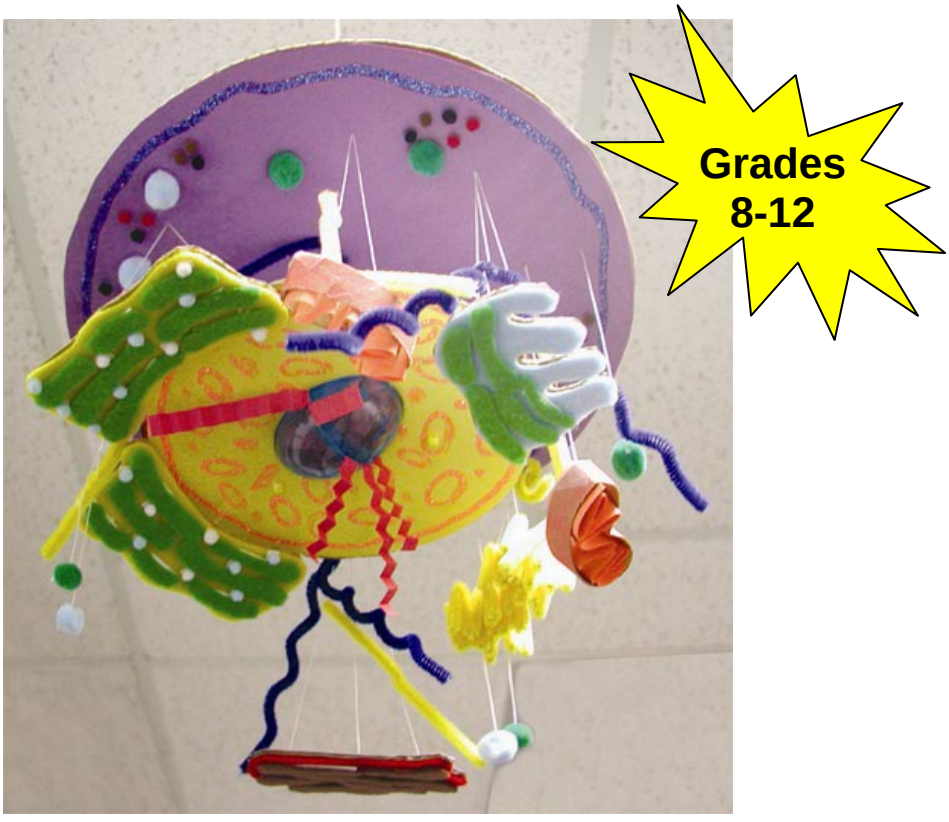
Outrageous Organelles

A Cell Mobile Project



Grades 8-12

JSC Exploration Cell Science project

produced by

wyle laboratories

http://slsd.jsc.nasa.gov/bso/

"Outrageous Organelles" Mobile Activity

Introduction
This activity implements kinesthetic learning to inspire students to create and work with their hands while developing a stronger understanding of the cell and its parts, or "organelles." The purpose of this activity is to build a cell model with an alteration to cell design which will allow more visualization of the cell's inner parts. While cells are enclosed structures, this model will dangle as a mobile and demonstrate the level of intracellular organization in a more linear format.

The cell body and cell (plasma) membrane functions as the main support structure for the mobile. All other parts are directly or indirectly carried by the cell body. The nucleus is a secondary platform to support other organelles. Further explanation of the mobile construction will follow later in this education brief.

Supplies
12" cardboard circle
7" cardboard circle
Tag board of various colors
Construction paper of various colors
Felt fabric of various colors
Plastic egg
Green and/or blue saran wrap
Aluminum foil
Thread or nylon fishing line
Pipe cleaners
Craft pom-poms or beans
4-hole button
Glue
Strong sewing needle
Scissors
Cellophane tape

Optional materials
Toilet paper tube and tissue paper
Glitter
Color markers, crayons, or pencils

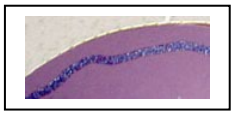
Cell Part	Materials	Attachment
Cell body	12" cardboard or tag board circle, decorated with construction paper, glitter, and different colors	Thread
Cell Membrane	Glitter or aluminum foil	Glue or staples
Centrosomes	Pipe cleaners	Thread
Chromosomes	Accordion-folded strips of paper	Pinched in the plastic egg
Cytoplasm	Strips of colored saran wrap	Tape
Cytoskeleton	Pipe cleaners	Thread
Golgi Apparatus	Felt and cardboard or tag board	Thread
Lysosome	Craft pom-poms or beans (A)	Glue
Mitochondrion	Construction paper or toilet paper tube and tissue paper	Thread
Nuclear Envelope	Glitter or aluminum foil	Glue
Nucleolus	Plastic egg	Glue
Nucleus	7" cardboard or tag board circle, decorated with construction paper, glitter, and different colors	Thread
Peroxisome	Craft pom-poms or beans (B)	Glue and/or Thread
Ribosome	Craft pom-poms or beans (C)	Glue and/or Thread
Rough Endoplasmic Reticulum	Felt and cardboard or tag board	Thread
Smooth Endoplasmic Reticulum	Felt and cardboard or tag board	Thread

Instructions

1. Color one side of the 12” circle with markers, or glue a piece of colored construction paper to it and cut off the excess. This will be the cell body.

2. Cut three 4’ pieces of thread or fishing line and tie a large knot at the end of each piece. Thread a piece of thread through the strong sewing needle and push the needle up through the colored side of the cardboard circle about 3” from the edge. Pull the thread through until the knot stops it from pulling any further. Repeat this process with the other two pieces of thread at evenly spaced distances around the cardboard circle. Attach the ends of the three threads at the top to the holes in a button. This will serve as a holder to hang your mobile from the ceiling.

3. Using glitter or aluminum foil, create a circle around the perimeter of the cell body. This will be the cell membrane.



4. Color one side of the 7” cardboard circle with markers, or glue a piece of colored construction paper to it and cut off the excess. This will be the nucleus.

5. Using glitter or aluminum foil, create a circle around the perimeter of the nucleus. This will be the nuclear envelope.

6. Cut 5-6 thin strips of construction paper and fold them back and forth, accordion-style. These will be the chromosomes. Insert the strips of accordion-folded paper into the plastic egg (nucleolus) and close it, so that a portion of each strip is sticking out. Attach the nucleolus to the nucleus by cutting a hole slightly smaller than the plastic egg in the center of the 7” cardboard circle and wedging or gluing the egg into the hole.

7. Cut three 6” pieces of thread. Dangle the nucleus from the cell body using the same process as in step 2, but instead of tying the threads to a button at the top tie a knot in the top of all three threads to keep them from slipping through the holes.

8. Use the templates and/or create various organelles with the suggested materials.
   - For the centrosomes: Fold 3 long pipe cleaners back and forth to create “M” or “W” shapes, then overlap them in a star pattern.

   - For the mitochondria: Option 1: Cut a toilet paper tube lengthwise and then in half and glue crumpled up tissue paper to the cupped insides. Option 2: Cut the toilet paper tube widthwise several times to form thin circles, bend in one side of the circle, and stuff with folded construction paper.

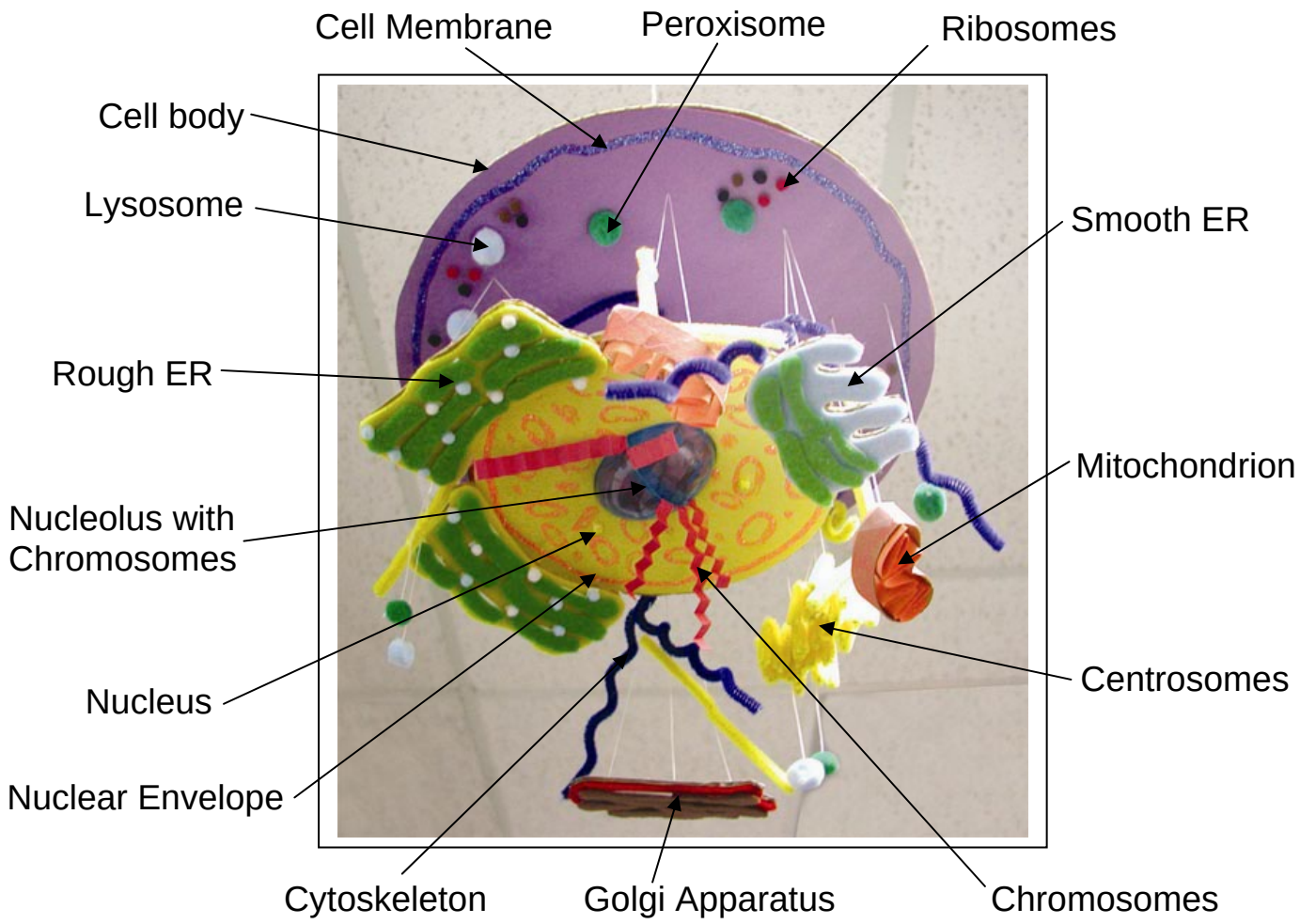
- For the lysosomes, peroxisomes, and ribosomes: Choose one color craft pom-pom or bean for each type and if possible make the ribosomes smaller than the others.

9. Attach the cell organelles to the cell body by gluing them to the 12” circle or hanging them with varying lengths of thread.

10. Cut strips of colored saran wrap (cytoplasm) to dangle from the cell body with tape.

11. Hang up your cell mobile for all to enjoy!!!

Example



The Cell
This section will provide a background on the cell and its parts. You can find a related interactive game online at http://slsd.jsc.nasa.gov/bso.

CELL
The most basic unit of life, cells are microscopic cities. They are filled with a watery fluid called protoplasm and numerous small machines called organelles or "little organs." Cells' small size allow for more surface area in relation to their volume. They may be part of larger tissues and organisms or be single-celled beings on their own like bacteria. Cells are divided into two groups: prokaryotes and eukaryotes. Prokaryotes are the most simple, single-celled organisms and do not have a nucleus bound in a membrane. Most cells however, are eukaryotic such as this human cell.

CENTROSOME
The centrosome is an important part of the cell's cytoskeleton. It is located near the nucleus and is the organization center for part of the cell's skeleton (microtubules). The centrosome contains a pair of centrioles which is a collection of 27 microtubules. When a cell prepares to divide, the two centrioles copy themselves to make four. Each pair of centrioles moves to opposite ends of the cell. These centrioles then act like two team captains, sending out microtubules to choose "players" (chromosomes) for their "teams" (two new cells).

CELL MEMBRANE
All human and animal cells have a kind of skin called a "membrane." The cell membrane is also known as the plasma membrane and allows nutrients, wastes, and cell products to pass through it. It controls the movement of anything into and out of the cell like a city wall with gates. Only so much of each thing can cross through "the gate" per second so membrane surface area is very important. Membranes between some parts of the cell are interchangeable. The Golgi Apparatus sends its secretion vesicles in its membrane to the outer cell membrane where the membranes combine together as part of the endomembrane system (Nuclear Envelope, Endoplasmic Reticulum, Golgi Apparatus, and Cell Membrane).

CHROMOSOME
Chromosomes are made of DNA (deoxyribonucleic acid) and proteins and are found in the nucleus. Usually, they are difficult to see as individual chromosomes, looking very stringy and tangled. This mess of genetic material is called chromatin. Chromosomes carry genes in linear order and when the cell is about to divide, they get organized and are the most visible thing in the nucleus. Different animals have different numbers of chromosomes. For example, human cells generally have 46 chromosomes.

CYTOPLASM
The cytoplasm is the part of the cell outside of the nucleus but together, they make up the protoplasm. The cytoplasm has a neutral pH of 7 and a watery fluid called cytosol where many of the organelles ("little organs") are found. Free-floating ribosomes can be found here, too. The cytoplasm also contains remains of cell parts ("floaties") broken down by the cell "clean-up crews" (lysosomes). These remains are the building blocks (precursors) used by organelles to rebuild themselves such as the Endoplasmic Reticulum's membrane.

CYTOSKELETON
The cytoskeleton not only provides the "bones" for the cell but also the "muscles." It is a mesh of fibers that maintains the shape of the cell, provides a place for organelles to anchor to, causes movement of the cell, and adds a "monorail system" for the organelles and vesicles to travel along. Some cells have moving hairs, tails, or bumps (cilia, flagella, microvilli) whose movement is also caused by the cytoskeleton. There are three main types of fibers in the cytoskeleton known as the microtubules (thickest), intermediate filaments, and microfilaments (thinnest; a.k.a. actin filaments).

GOLGI APPARATUS
The Golgi Apparatus is the "packing and shipping office" in the cell. Some say that it looks like a stack of pita bread. It is actually an organelle with many sac-like compartments called cisternae. The Golgi has a "receiving" side and a "shipping" side. It receives proteins from the Rough ER (Rough Endoplasmic Reticulum) and alters them for different uses. Some proteins from the Rough ER are packaged and sent (secreted as secretory

vesicles) out of the cell. The Golgi also wraps proteins with membrane and coats them with markers to help them “dock” with other organelles. The Golgi gets membrane from the Rough ER and is part of the endomembrane system (Nuclear Envelope, Endoplasmic Reticulum, Golgi Apparatus, and Cell Membrane).

LYSOSOME
Lysosomes are the “clean-up crews” of the cell. They are sacs (vesicles) of acidic (pH 5) proteins made by the Rough ER (Rough Endoplasmic Reticulum) that can dissolve bacteria, old cells, organelles, and materials that do not belong in the cell. A cell may surround something unwanted and contain it, or “eat” (phagocytosis) it in a stomach-like vacuole. Lysosomes break into the vacuole and release their dissolving proteins. By breaking up organelles within the cell, they create a supply of “spare parts” or “floaties” that remain in the cytoplasm until they become building blocks (precursors), reused by other organelles. When an entire cell needs to be destroyed, lysosomes within the cell can all break open and destroy the entire cell (autolysis; giving lysosomes the nickname “suicide sacs.”)

MITOCHONDRION
A mitochondrion is the “powerhouse” of the cell. There can be many mitochondria in a cell’s cytoplasm. In fact, the number of them found gives an idea of the amount of energy needed for the cell. Mitochondria use free ribosomes in the cytosol and have their own ribosomes to make their own double membrane. They pull “spare parts” from the cytosol to make the smooth outer membrane and the many folds (cristae) of the inner membrane. The folds offer more surface area to change oxygen and glucose, a form of sugar, into energy in the form of ATP (adenosine triphosphate). Mitochondria are the size of a single bacteria and have their own DNA.

NUCLEAR ENVELOPE
The nuclear envelope is the double membrane around the nucleus in eukaryotic cells. It is the main difference between prokaryotes and eukaryotes because prokaryotes do not have one. This membrane has pores that allow passage of substances in and out, such as mRNA (messenger ribonucleic acid), from the nucleus to go out to the cytoplasm. The nuclear envelope blends into the ER (Endoplasmic Reticulum) membrane of the endomembrane system (Nuclear Envelope, Endoplasmic Reticulum, Golgi Apparatus, and Cell Membrane).

NUCLEOLUS
The nucleolus is found in the *nucleus*. It is the most prominent part of the nucleus when the cell is not dividing and looks like a dark spot. A nucleolus is made of specialized regions of *chromosomes*, RNA (ribonucleic acid), and proteins. The proteins are actually ribosomes in different stages of production. More than one *nucleoli* can be found in a nucleus. They are roughly spherical in shape and are involved in the assembly of ribosomes.

NUCLEUS
The nucleus is the “control center” of the cell. It holds the cell’s inherited genes as DNA (deoxyribonucleic acid) in the form of chromosomes and controls the protein production in the cytoplasm by sending out mRNA (messenger ribonucleic acid). The mRNA is the blueprint of DNA in the nucleus and tells the ribosomes what to build.

PEROXISOME
Peroxisomes are single membrane organelles with proteins but do not come from the “packaging and shipping office” (Golgi Apparatus). Peroxisomes absorb building blocks, such as proteins and fats, from their surroundings in the cytosol and split when they get too big. They are usually spherical in shape and form hydrogen peroxide (H2O2) as a product of breaking down fats and toxins. Peroxisomes also convert harmful H2O2 to water (H2O) with special proteins.

RIBOSOME
Ribosomes create the building blocks, or polypeptides, for forming proteins and are made by the nucleolus in the nucleus out of cytoplasm proteins and rRNA (ribosomal ribonucleic acid). They can be found “bound” to the Rough ER (Rough Endoplasmic Reticulum) or floating “free” in the cytoplasm. Ribosomes are what add the “roughness” to the Rough ER. They receive commands from the nucleus in the form of mRNA (messenger

ribonucleic acid) to create polypeptides. Free ribosomes make polypeptides that remain in the cytoplasm of the cell while bound ribosomes make polypeptides that will either be part of a membrane or sent out (secreted out) of the cell. Cells that secrete hormones and enzymes have a higher amount of bound ribosomes compared to free ribosomes.

ROUGH ENDOPLASMIC RETICULUM

The Rough Endoplasmic Reticulum (Rough ER) holds many ribosomes which give it a rough appearance. It is a continuation of the nuclear envelope and merges with the Smooth ER but also makes its own membrane from “spare parts” in the cytosol. Proteins are made from ribosomal polypeptides and, in the Rough ER, will either be part of membranes or eventually sent (secreted as secretory vesicles) out of the cell by the Golgi Apparatus. Cells that send proteins out are common in the stomach and intestinal lining to digest food. They are also found in the pancreas to form insulin, a protein to help break down a complex stored form of sugar (glycogen). The Rough ER adds sugar chains to the proteins and gives up part of its own membrane to wrap them for shipping to the Golgi Apparatus (packaging and shipping center). The Golgi also absorbs the Rough ER wrapping membrane to include in its own membrane as part of the endomembrane system (Nuclear Envelope, Endoplasmic Reticulum, Golgi Apparatus, and Cell Membrane).

SMOOTH ENDOPLASMIC RETICULUM

Together, the Smooth and Rough Endoplasmic Reticulum (ER) make up a large network of membranes within the cytoplasm called the endomembrane system (Nuclear Envelope, Endoplasmic Reticulum, Golgi Apparatus, and Cell Membrane). The Smooth ER makes its own membrane from “spare parts” in the cytoplasm. It also makes fats, hormones, and steroids such as testosterone, estrogen, and adrenaline. The Smooth ER helps with the break down of complex sugars stored in the liver and also makes proteins (enzymes) that detoxify drugs and poisons. It makes poisons more soluble and easier to flush out of the body. Tolerance to medication is due to increased amount of the Smooth ER and its enzymes.